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ABSTRACT

Physics 30 is a twelfth-grade physics course for students in Alberta, Canada. This document is a final test for the course. Intended for administration during January 1985, it contains 56 multiple-choice questions and four written-response problems. Two-and-one-half hours are allowed for completing the test. No answer key is included since scoring is done by the province education department. (JN)

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GRADE 12 DIPLOMA EXAMINATION

Physics 30

January 1985

Alberta
EDUCATION

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GRADE 12 DIPLOMA EXAMINATION
PHYSICS 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination consisting of two parts:

PART A: 56 multiple-choice questions each with a value of 1 mark.

PART B: Four written-response questions for a total of 14 marks.

GENERAL INSTRUCTIONS

Fill in the information on the answer sheet as directed by the examiner.

For multiple-choice questions, read each carefully and decide which of the choices BEST completes the statement or answers the question. Locate that question number on the answer sheet and fill in the space that corresponds to your choice. USE AN HB PENCIL ONLY.

Example

This examination is for the subject area of

A. Chemistry
B. Biology
C. Physics
D. Mathematics

Answer Sheet

A	B	C	D
①	②	●	④

If you wish to change an answer, please erase your first mark completely.

For written-response questions, read each carefully, show all your calculations, and write your answer in the space provided in the examination booklet.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

JANUARY 1985

PART A

INSTRUCTIONS

There are 56 multiple-choice questions with a value of one mark each in this section of the examination. Use the separate answer sheet provided and follow the specific instructions given.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

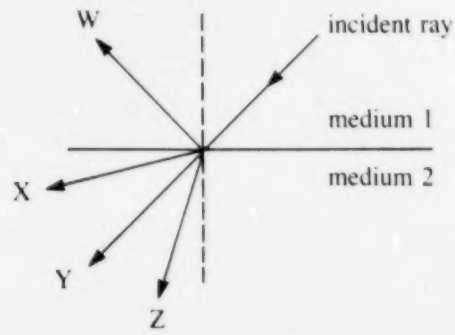
WHEN YOU HAVE COMPLETED PART A, PROCEED DIRECTLY TO PART B

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER.

1. The idea that light is a transverse wave is supported by evidence that light

   A. can be polarized
   B. bends toward the normal when slowing down
   C. bends away from the normal when speeding up
   D. waves will interfere with each other when passing through two narrow slits

Use the following information to answer question 2.



A ray of light slows down as it passes from medium 1 to medium 2.

2. The ray that represents the refracted light is

   A. W
   B. X
   C. Y
   D. Z

---

3. After light passes from air into a second medium, its speed is observed to be 2.0×10^8 m/s. The index of refraction of the second medium is

   A. 0.67
   B. 1.3
   C. 1.5
   D. 6.0

4. A diffraction grating with slits 0.020 mm apart produces an interference pattern on a screen 0.80 m away. If the bright lines are 18 mm apart, the wavelength of the light used is

   A. 8.9×10^{-4} m
   B. 6.3×10^{-5} m
   C. 5.2×10^{-6} m
   D. 4.5×10^{-7} m

5. In air, light can be polarized and sound cannot. This is evidence that sound waves

   A. are very much longer than light waves
   B. diffract to a much greater extent than light waves
   C. are longitudinal whereas light waves are transverse
   D. require a medium for propagation whereas light waves do not

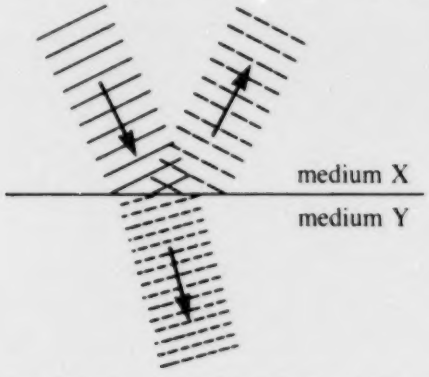
6. The atmosphere scatters blue light more than red light because blue light has a

   A. lower velocity
   B. lower frequency
   C. longer wavelength
   D. shorter wavelength

7. Two phenomena of light that are best explained by a wave model are

   A. reflection and refraction
   B. polarization and reflection
   C. diffraction and interference
   D. dispersion and the photoelectric effect

Use the following information to answer question 8.



The diagram shows a wave front passing from medium X to medium Y.

8. The light in medium Y travels

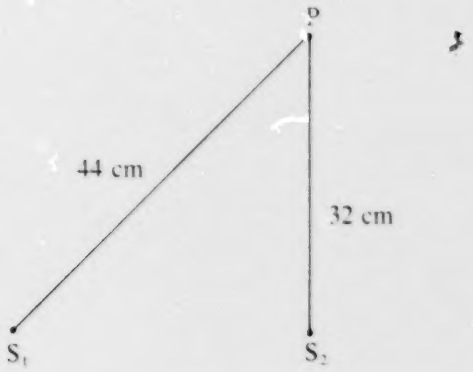
   A. faster and has a lower frequency
   B. slower and has a lower frequency
   C. faster and has a shorter wavelength
   D. slower and has a shorter wavelength

9. A light signal is sent from Earth to the moon, a distance of 3.7×10^{8} m. Assuming that it is possible for the light to be reflected back to the same point on Earth, how much time is required for the signal to travel to the moon and back?

A. 8.1 s
B. 2.5 s
C. 1.2 s
D. 0.83 s

Use the following information to answer question 10.

S_1 and S_2 produce waves with a wavelength of 8 cm. These waves are one-half wavelength out of phase.



10. The waves at point P will show

A. standing waves
B. destructive interference
C. constructive interference
D. that harmonics are possible

---

11. The electromagnetic wave that would be scattered the LEAST by a particle of dust has a wavelength of

A. 4.0×10^{-6} m
B. 7.0×10^{-7} m
C. 4.0×10^{-7} m
D. 7.0×10^{-8} m

12. If a small object with a charge of 10.0 C is located 5.0 m from another small object with a charge of 10.0 C, then the electrical force between them is

A. 1.8×10^{10} N
B. 2.4×10^{10} N
C. 3.0×10^{10} N
D. 3.6×10^{10} N

13. The power dissipated in maintaining a potential difference of 5.0 V across the terminals of a 500.0 Ω resistor is

A. 2.5×10^{3} W
B. 1.3×10^{2} W
C. 2.0×10^{1} W
D. 5.0×10^{-2} W

14. The magnitude of the electric field exerting a force of 0.60 N on a charge of 40.0 μC is

A. 1.5×10^{4} V/m
B. 1.5×10^{-2} V/m
C. 6.7×10^{-5} V/m
D. 2.4×10^{-5} V/m

15. An example of electrostatic attraction is the force between

A. a pair of magnets
B. a magnet and a piece of iron
C. a charged and a neutral object
D. a pair of similarly charged glass rods

16. The direction of an electric field is opposite to the direction of the force it exerts on

A. protons
B. electrons
C. positrons
D. neutrinos

17. One coulomb is defined as the

A. charge of one mole of electrons
B. force experienced by a unit of charge
C. charge that flows in one second when the current is one ampere
D. power produced when energy flows at a rate of one joule per second

18. The current in a single resistor circuit is 4.0 A when a 24 V battery is used. If a 6.0 V source is used instead, and the resistance of the circuit is halved, the new current will be

A. 8.0 A
B. 2.0 A
C. 1.0 A
D. 0.50 A

19. A charged object travels perpendicularly through a magnetic field of 2.0 T at 10.0 m/s. The number of excess electrons that the object must have in order to experience a force of 3.2×10^{-9} N is

A. 1.6×10^{-16}
B. 1.0×10^{3}
C. 1.0×10^{9}
D. 6.2×10^{18}

20. If the force between two charged particles is to remain unaltered after the charge on one particle is doubled and the charge on the other is increased to eight times its original value, then the distance between the charges should be

A. decreased to $^{1}/_{256}$ of the original
B. decreased to $^{1}/_{4}$ of the original
C. increased to 4 times the original
D. increased to 256 times the original

21. When an electron is accelerated through a potential difference of 1 V, the kinetic energy required is

A. 1 J
B. 1 V
C. 1 W
D. 1 eV

22. How does the strength of the electric field due to a charged particle vary as the distance from the particle changes?

A. Directly as the distance
B. Inversely as the distance
C. Directly as the square of the distance
D. Inversely as the square of the distance

23. A charge of 2.0×10^{-6} C experiences a force of 8.0×10^{-2} N at a certain point in an electric field. The strength of the field at this point is

A. 2.0×10^{6} N/C
B. 4.0×10^{4} N/C
C. 2.5×10^{-5} N/C
D. 1.6×10^{-7} N/C

Use the following information to answer question 24.

I	Only electrical forces follow the inverse square law.
II	Only gravitational forces follow the inverse square law.
III	Electrical forces are greater than gravitational forces.
IV	Gravitational forces produce the same effects as electrical forces.

24. Which of the statements about the forces between electrically charged elementary particles is true?

A. I
B. II
C. III
D. IV

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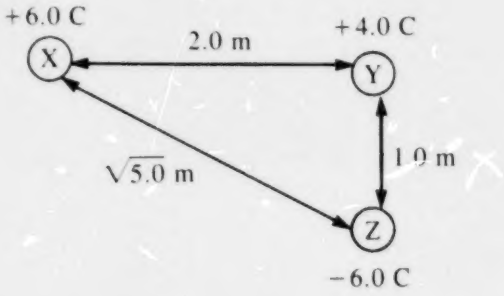
25. The aurora borealis results from

A. reflection and refraction of sunlight from polar ice-caps
B. fluorescence of air molecules after the absorption of ultraviolet light from the sun
C. charged particles trapped in Earth's magnetic field interacting with gaseous atoms in the atmosphere
D. a discharge of energy by particles that are accelerated when they interact with Earth's electric field

Use the following information to answer question 25.



26. The magnitude of the force acting on Y due to X and Z is

A. 7.6×10^{11} N
B. 2.2×10^{11} N
C. 3.2×10^{10} N
D. 2.7×10^{10} N

---

27. A proton oscillates between two points. If the time for one complete cycle is 1.3×10^{-17} s, what is the wavelength of the emitted radiation?

A. 2.6×10^{8} m
B. 4.3×10^{-9} m
C. 3.9×10^{-9} m
D. 7.5×10^{-16} m

28. A changing magnetic field will produce

A. an electric field around itself
B. two regions of opposite electric charges
C. an equal but opposite pair of magnetic poles
D. a lower total energy within the magnetic field

29. The frequency of an AM radio wave with a wavelength of 4.05×10^{2} m is

A. 1.35×10^{-6} Hz
B. 8.15×10^{-1} Hz
C. 7.41×10^{5} Hz
D. 1.22×10^{11} Hz

30. Radio waves CANNOT be used to measure the position of atoms in crystals because

A. radio waves are absorbed by crystals
B. crystals can only receive a particular frequency
C. radio waves travel too fast to be affected by the atoms
D. the wavelength of radio waves is greater than the size of the atoms

31. Different kinds of electromagnetic radiation

A. require a different ether
B. require a different medium
C. travel at the same speed in a vacuum
D. have the same frequency in a vacuum

32. A spark is made to jump an air gap. As a result, in the next room a small spark jumps another small air gap. This may provide evidence for the existence of

A. the ether
B. photoelectrons
C. electromagnetic waves
D. ultrasonic polarized waves

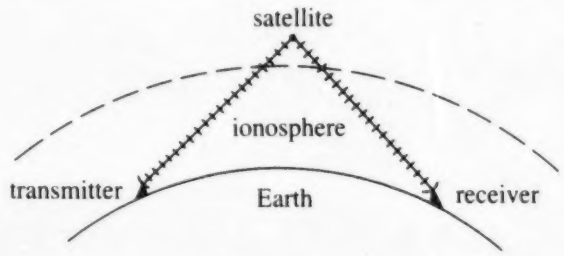
33. By applying a magnetic field to a piece of glass through which light was passing, Faraday found that the light's

A. speed increased
B. frequency decreased
C. wavelength lengthened
D. plane of polarization rotated

34. An electric field increasing in magnitude would set up a

A. radial electric field
B. radial magnetic field
C. circular electric field
D. circular magnetic field

Use the following information to answer question 35.



The diagram shows a satellite relaying information from one continent to another.

35. The signal most likely travels by

A. gamma radiation
B. infra-red radiation
C. microwave radiation
D. ultraviolet radiation

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36. A 10 cm wire moves perpendicularly to a magnetic field of 5 T. If the current through the wire is 1 A, then the force required to move the wire is

A. 0.5 N
B. 5 N
C. 20 N
D. 50 N

37. In a charge-to-mass experiment, it is found that electrons travelling at 7.0×10^{6} m/s are deflected in a circular arc of 0.40 m radius by a 1.0×10^{-4} T magnetic field. The q/m ratio for this experiment is

A. 5.7×10^{11} C/kg
B. 3.8×10^{11} C/kg
C. 2.8×10^{11} C/kg
D. 1.8×10^{11} C/kg

38. The energy of a photon with a frequency of 5.0×10^{14} Hz is

A. 2.4×10^{-21} J
B. 2.4×10^{-21} eV
C. 3.3×10^{-19} J
D. 3.3×10^{-19} eV

39. The wavelength of the spectral line for $n_i = 3$ in the Balmer series ($n_f = 2$) is

A. 4.5×10^{14} m
B. 1.5×10^{6} m
C. 6.5×10^{-7} m
D. 2.2×10^{-15} m

40. If the threshold frequency of a metal is 2.3×10^{15} Hz, then its work function is

A. 1.4×10^{34} eV
B. 9.5 eV
C. 4.1×10^{-15} eV
D. 3.7×10^{-15} eV

41. The radius of the fifth Bohr orbit of hydrogen is

A. 1.3×10^{-9} m
B. 4.8×10^{-10} m
C. 2.7×10^{-11} m
D. 1.1×10^{-11} m

42. Zinc used in a photoelectric cell is irradiated by electromagnetic radiation of frequency 5.3×10^{15} Hz. If the work function for zinc is 6.4×10^{-19} J, what is the maximum kinetic energy of the photoelectrons that are emitted?

A. 3.4×10^{-3} J
B. 9.7×10^{-14} J
C. 2.9×10^{-18} J
D. 3.5×10^{-18} J

43. Einstein explained the photoelectric effect by proposing that light

A. has an energy of mc^2
B. has a momentum of hf/c
C. consists of quanta of energy equal to hf
D. travels at a constant speed c relative to all observers

44. Which is a characteristic of cathode rays?

A. Cathode rays are affected by magnetic fields.
B. Cathode rays are positively charged particles.
C. The nature of the cathode determines the nature of cathode rays.
D. The direction of propagation of cathode rays is toward the cathode.

45. An electron drops from one energy level to another within an excited hydrogen atom producing a photon with a frequency of 2.5×10^{15} Hz. The wavelength of this photon is

A. 8.3×10^{-6} m
B. 1.2×10^{-7} m
C. 1.8×10^{-11} m
D. 7.5×10^{-23} m

46. The number of atoms of an element deposited in electrolysis depends on the element's

A. valence
B. Z/v ratio
C. atomic number
D. photoelectric work function

47. The hypothesis that atoms have positive nuclei was first suggested by

A. Bohr
B. Balmer
C. Thomson
D. Rutherford

48. In quartz, yellow light has a wavelength of 3.82×10^{-7} m and a frequency of 5.09×10^{14} Hz. The velocity of the light in quartz is

A. 1.94×10^{8} m/s
B. 3.00×10^{8} m/s
C. 5.13×10^{9} m/s
D. 1.33×10^{21} m/s

49. An electron that has a kinetic energy of 6.0×10^3 eV collides with a tungsten anode, which results in the emission of an X-ray. The wavelength of the X-ray is

A. 2.1×10^{-10} m
B. 3.1×10^{-15} m
C. 6.9×10^{-19} m
D. 3.3×10^{-29} m

50. Electrons with a maximum kinetic energy of 4.0 eV are ejected from a metal surface by incident light with a wavelength of 2.0×10^{-7} m. The work function of this metal is

A. 4.0 eV
B. 3.5 eV
C. 2.2 eV
D. 1.1 eV

51. The most widely accepted theories involving electromagnetic radiation propose that it

A. must have a wave-particle nature in accordance with Schrödinger's wave equation

B. must have a wave nature, because all of its characteristics can now be explained on the basis of wave nature

C. is neither a wave nor a particle but something entirely different, as described by Heisenberg's uncertainty principle

D. has some characteristics that can only be explained by assuming a wave nature and others that can only be explained by assuming a particle nature

52. If the de Broglie wavelength is 6.80×10^{-10} m for a particle travelling at 2.60×10^6 m/s, the mass of the particle is

A. 3.75×10^{-31} kg
B. 3.75×10^{-30} kg
C. 3.75×10^{-29} kg
D. 3.75×10^{-27} kg

53. Which observation is valid with respect to relativity theory?

A. Mass, acceleration, and force are invariant quantities for a high-speed particle.
B. When a particle moves at velocities exceeding 7.5×10^7 m/s, its mass increases significantly.
C. The momentum of a high-speed particle is equivalent to the particle's original mass times its velocity.
D. The force required to accelerate a particle to high speeds is inversely proportional to the original mass of the particle.

54. Quantum mechanics is a theory of the nature of matter that provides a

A. clear picture of the hydrogen atom
B. highly visual physical model of the atom
C. mathematical representation that can be used to predict interactions among particles, fields, and radiation
D. means of calculating the position and physical condition of any individual electron in any individual atom

55. X-rays of frequency 3.5×10^{19} Hz are incident upon a carbon block. X-rays of frequency 8.2×10^{18} Hz and some electrons come out of the carbon block. If the Compton effect is taking place, the energy of these electrons is

A. 2.3×10^{-14} J
B. 1.8×10^{-14} J
C. 5.4×10^{-15} J
D. 1.9×10^{-15} J

56. The momentum of a photon having a frequency of 5.0×10^{19} Hz is

A. 1.3×10^{-48} kg•m/s
B. 3.9×10^{-45} kg•m/s
C. 1.1×10^{-22} kg•m/s
D. 3.3×10^{-14} kg•m/s

YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION. PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

Marks will be awarded for pertinent explanations, calculations, formulas, and answers. Answers must be given to the appropriate number of significant digits.

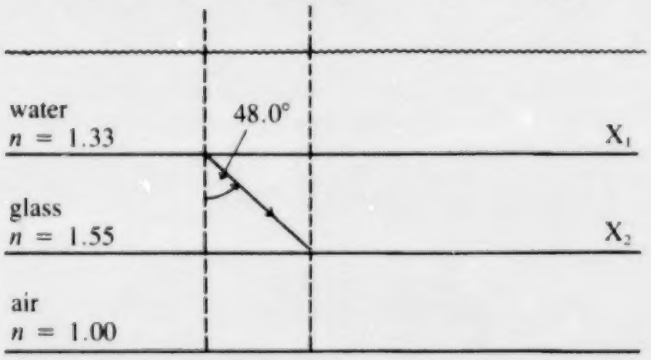
NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

TOTAL MARKS: 14

START PART B IMMEDIATELY

Use the following information to answer questions 1 and 2.

The light ray in glass is refracted at an angle of 48.0° to the normal.



(2 marks) **1.** In the diagram above, draw the incident ray of the path of light as it was incident on X_1 (water - glass) to produce the ray given. Give supporting evidence for the path of light in terms of the resulting angles of refraction. Show all your calculations where appropriate.

(3 marks) **2.** In the same diagram, draw the path of light at interface X_2 (glass - air). Give supporting evidence for the path of light at this interface in terms of the resulting angles of refraction or reflection. Show all your calculations where appropriate.

Use the following information to answer question 3.

In an experiment designed to replicate the work of J. J. Thomson, the charge-to-mass ratio of the electron was determined. The experiment was designed to measure the bending of the electron beam by a known magnetic field. From these measurements and a knowledge of the voltage accelerating the electrons, the charge-to-mass ratio of the electron may be calculated using the formula:

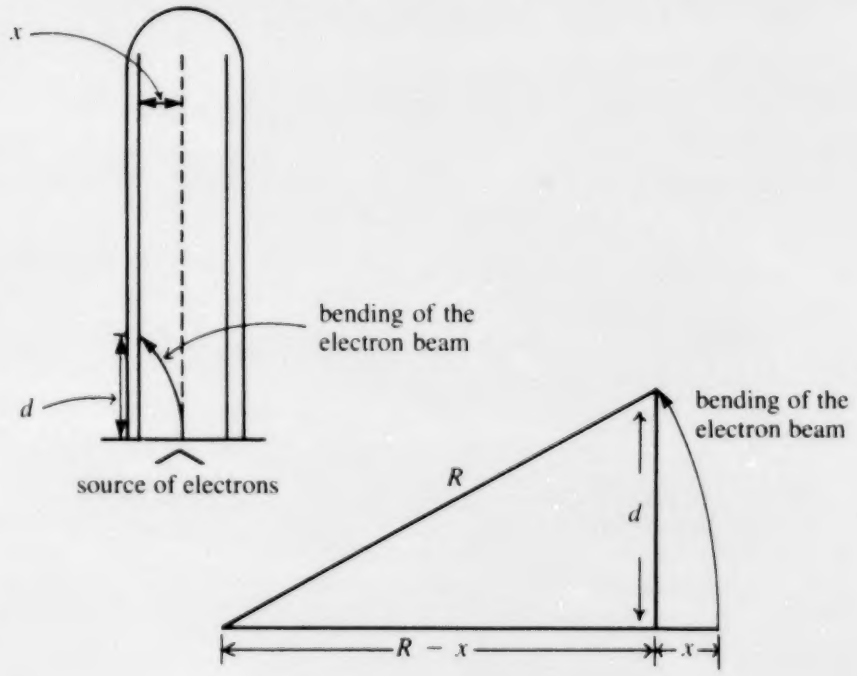
$$\frac{q_e}{m} = \frac{2V}{B^2R^2}$$

The following information was recorded:

Accelerating voltage, $V = 150$ V

Magnetic field, $B = 5.2 \times 10^{-4}$ T

The bending of the electron beam was described by the following diagrams where $x = 0.75$ cm and $d = 2.5$ cm.



(2 marks) **3. a.** Using the information from the DIAGRAMS, determine the radius, R, for the path of the electrons.

(2 marks) **b.** Calculate the charge-to-mass ratio for the electron using data obtained from this experiment. (NOTE: If you were unable to determine a value for the radius R, use $R = 4.5 \times 10^{-2}$ m for your calculation here.)

(1 mark) **c.** Determine the percentage error for the value that you calculated in b.

(4 marks) **4.** An electron is accelerated through a potential difference of 1.00×10^6 V. Calculate the relativistic speed of the electron. Show your calculations. Express your answer to the appropriate number of significant figures and include appropriate units.

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

TEAR-OUT
SHEET

(NO MARKS WILL BE GIVEN FOR WORK DONE ON THIS PAGE)

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